In the Claims

This listing of claims will replace all prior versions, and listings, of claims in the application.

1. (currently amended) A method of monitoring the capacity of a valve regulated lead acid battery, comprising:

connecting at least one battery monitor to said valve regulated lead acid battery;

connecting said monitor to a centralized system through an industry standard data system that collects and transfers data from the field to a central office;

providing said centralized system with an alarm;

performing a short-term discharge test on said battery using said battery monitor; and

obtaining a predicted capacity using a neural network and fuzzy logic network in combination with a prediction algorithm;

training said neural network for a specific battery type in a lab by determining the actual capacity of a battery, inputting parameters with the actual capacity used as a target, and programming the set of coefficients yielded by said neural network in said battery monitor;

wherein, said discharge test provides input parameters for said networks which in combination with said prediction algorithm calculate said predicted capacity, and wherein, said alarm is activated when said predicted capacity falls below ~~eighty percent~~ a predetermined percentage, when an individual cell voltage is reduced to about 1.95 volts or less, or when a system failure occurs.

2. (pending) A method as in claim 1, wherein said battery monitor consists of hardware for monitoring the voltages of each battery cell and currents that are flowing into and out of said battery.

3. (pending) A method as in claim 1, wherein said battery monitor contains a serial port enabling data to be downloaded onto a network, computer, or printer.

4. (pending) A method as in claim 3, further comprising a real time clock.

5. (pending) A method as in claim 4, wherein said real time clock is automatically verified and updated through said network.

6. (allowed) A method as in claim 1, wherein said discharge test is a four hour discharge test.

7. (allowed) A method as in claim 1, wherein said discharge test collects specific data parameters including the cell age, open circuit voltage, voltage after one hour of discharge, voltage after three hours of discharge, and voltage after four hours of discharge.

8. (allowed) A method as in claim 7, wherein said parameters are used to derive three additional data points including the slope of the discharge curve, the delta between voltages at three and four hours, and the proximity to two volts of the four hour voltage.

9. (pending) A method as in claim 1, wherein said discharge test is performed on a repeated basis.

10. (deleted) ~~A method as in claim 1, wherein said neural network is trained for a specific battery type in a lab by determining the actual capacity of a battery, inputting said parameters with the actual capacity used as a target, and programming the set of coefficients yielded by said neural network into an EEPROM which is inserted in said battery monitor.~~

11. (objected to) A method as in claim ~~10~~ 1, wherein said actual capacity is determined by the following formula:

(time to discharge to 1.75V X 24 hour discharge rate)/(24 X 24-hour discharge rate in amps).

12. (objected to) A method as in claim ~~10~~ 1, wherein said neural network is trained only once.

13. (objected to) A method as in claim 1, wherein said fuzzy logic network comprises:

dividing total battery capacity into capacity spans of ten percent;

associating a voltage range with each of said ten percent spans, wherein said voltage range was previously determined from said 24-hour rate discharge lab tests;

determining within which of said capacity spans said voltage ranges fall by comparing each of said open, one, three, and four hour cell voltages with the known base lines for the specific battery type;

determining the strength value of the cell's voltage within a particular span;

determining the capacity range with the most positive strength value;

adjusting the range that is immediately above said capacity range with most positive strength value by adding the strength value of said range to the lowest capacity value of said range to yield the upper capacity limit;

adjusting the range that is immediately below said capacity range with most positive strength value by subtracting the strength value of said range from the highest capacity value of said range to yield the lower capacity limit;

wherein, said difference between said upper capacity limit and said lower capacity limit yields the fuzzy logic capacity range span.

14. (objected to) A method as in claim 13, wherein said strength value is determined as follows:

calculating the average voltage for each capacity range using the maximum and minimum voltage values;

dividing the cell test voltage (open, one, three, or four hour) by said average voltage;

subtracting the quotient of previous step from one and taking the absolute value of the difference;

performing this calculation for each of said cell test voltages--open ,one, three, and four hour;

adding the calculated values for each of said cell test voltages and dividing the sum by seventy; and

subtracting the quotient of the previous step from one;

wherein, the value of said strength value can be positive or negative.

15. (objected to/amended) The method of claim 1, wherein said neural network comprises:

inputting parameters including open, one-hour, three-hour, and four-hour cell voltages and the age of said battery;

obtaining three more data points from said parameters including slope of the discharge curve, the delta between voltages at three and four hours, and the proximity to two volts of the four hour voltage;

outputting a number between zero and one;

wherein, said neural network performs calculations as any standard neural network using the coefficients determined from said training of said network using lab data; and

wherein, the output of said neural network is multiplied by the span of the capacity range obtained from the fuzzy logic network and adding this product to said lower capacity limit in order to determine the final capacity ~~predicition~~ prediction.

16. (amended) An apparatus for monitoring the capacity of a valve regulated lead acid battery, comprising:

at least one battery monitor connected to said valve regulated lead acid battery, said battery monitor having a neural network trained in a lab for a specific battery type by determining the actual capacity of a battery, inputting parameters with the actual capacity used as a target, and programmed with a set of coefficients yielded by said neural network and a fuzzy logic network;

a prediction algorithm, said prediction algorithm using data produced by said neural network and fuzzy logic network,

a centralized system connecting said battery monitor through an industry standard data system to a central office;

an alarm connected to said centralized system.[[;]]

[[wherein, said battery monitor contains a neural network and a fuzzy logic network used in combination with a prediction algorithm; and

wherein, said battery monitor contains a means for acquiring all data needed for said prediction algorithm]].

17. (rejected) An apparatus as in claim 16, wherein said battery monitor consists of hardware for monitoring the voltages of each battery cell and currents that are flowing into and out of said battery.

18. (rejected) An apparatus as in claim 16, wherein said battery monitor contains a serial port enabling data to be downloaded onto a network, computer, or printer.

19. (rejected) An apparatus as in claim 18, further comprising a real time clock.

20. (rejected) An apparatus as in claim 19, wherein said real time clock is automatically verified and updated through said network.

21. (allowed/amended) A method of monitoring the capacity of a valve regulated lead acid battery, comprising:

connecting at least one battery monitor to said valve regulated lead acid battery;

connecting said monitor to a centralized system through an industry standard data system that collects and transfers data from the field to a central office;

providing said centralized system with an alarm;

performing a short-term discharge test on said battery; and

obtaining a predicted capacity using a neural network and fuzzy logic network in combination with a prediction algorithm;

wherein, said discharge test comprises a four hour discharge of said battery, performed at a discharge rate calculated from the amp-hour size of the battery and a 24-hour period, during which specific data parameters consisting of cell age, open circuit voltage, voltage after one hour of discharge, voltage after three hours of discharge, and voltage after four hours of discharge are logged and three additional parameters including three hour slope, the delta between the three and four hour voltages, and the proximity to two volts of the four hour voltage are determined; and

wherein said neural network is trained in a lab by determining the actual capacity of a battery using the following formula:

(time to discharge to 1.75V X 24 hour discharge rate)/(24 X 24-hour discharge rate in amps),

inputting said parameters with the actual capacity used as a target, and programming the set of coefficients yielded by said neural network into an EEPROM which is inserted in said battery monitor; and

wherein, said fuzzy logic network comprises dividing total battery capacity into capacity spans of ten percent; associating a voltage range with each of said ten percent spans, wherein said voltage range was previously determined from said 24-~~hou~~ hour rate discharge lab tests; determining within which of said capacity spans said voltage ranges fall by comparing each of said open, one, three, and four hour cell voltages with the known base lines for the specific battery type; determining the strength value of the cell's voltage within a particular span by the following steps:

calculating the average voltage for each capacity range using the maximum and minimum voltage values; dividing the cell test voltage (open, one, three, or four hour) by said average voltage; subtracting the

quotient of previous step from one and taking the absolute value of said answer; performing this calculation for each of cell test voltages (open one, three, and four hour); adding the calculated values for each of said cells test voltages and dividing the sum by seventy; and subtracting the quotient of the previous step from one; determining the capacity range with the most positive strength value; adjusting the range that is immediately above said capacity range with most positive strength value by adding the strength value of said range to the lowest capacity value of said range to yield the upper capacity limit; and adjusting the range that is immediately below said capacity range with most positive strength value by subtracting the strength value of said range from the highest capacity value of said range to yield the lower capacity limit; wherein, said difference between said upper capacity limit and said lower capacity limit yields the fuzzy logic capacity range span; and

wherein, said neural network comprises inputting parameters including open, one-hour, three-hour, and four-hour cell voltages and the age of said battery; obtaining three more data points from said parameters including slope of the discharge curve, the delta between voltages at three and four hours, and the proximity to two volts of the four hour voltage; and outputting a number between zero and one; wherein, said neural network performs calculations as any standard neural net using the coefficients determined from said training of said network using lab data; and wherein, the output of said neural network is multiplied by the span of the capacity range obtained from the fuzzy logic network and adding this product to said lower capacity limit in order to determine the final capacity prediction.